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THE MURFREESBORO STAGE OF OUR EAST COAST MIOCENE

BY

AXEL OLSSON

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Introduction

Forming a no small part of the sedimentary deposits composing the northern half of our eastern Coastal Plain in New Jersey, Maryland, Virginia and North Carolina are the beds collectively known as the Miocene. They consist of clays, sands, marls or their mixtures, often with an abundant and interesting fauna, which has been the subject of study of several paleontologists since the time of Thomas Say. On the basis of faunal differences and stratigraphy, the series may be divided into stages; and, when these are studied, the former transgressions of the Miocene sea at the corresponding ages are determined. The stages which may be recognized at present, are the following:

- Upper
  - Upper
    - Duplin stage, south of the Hatteras axis
    - Yorktown stage, north of the Hatteras axis
  - Lower—Murfreesboro stage (*new*)
- Middle—St. Mary's stage
- Lower
  - Upper—Choptank stage
  - Lower—Calvert stage

It is the purpose of the present paper to name and characterize the new Miocene stage, occupying, as indicated above, a position in the lower Upper Miocene, that is, between the St. Mary's and the Yorktown stages. To this group of beds the name, the Murfreesboro stage, is here proposed; and for its type exposures, the Miocene at Murfreesboro, N. C., and along the Meherrin river in the immediate vicinity of Murfreesboro, is selected, although a number of other places in North Carolina or Virginia would serve equally well. Throughout its areal distribution, the stage is uniform and in many respects represents the most typical expression of our east coast, or cold water Miocene to which the name Chesapeake is generally given. After its close, and during the Yorktown, changes towards the warmer Pliocene were inaugurated and new faunal elements introduced.

POSITION AND LITHOLOGY

The Murfreesboro stage consists of blue sandy clays, immediately overlain by the yellow sands and light-colored marls of the Yorktown stage; and, owing to the general seaward dip of this region, its distribution is more inland and to the west of the latter. Where the basal beds are exposed, they are seen to rest upon a number of different formations. At Petersburg, it is upon the Cretaceous, or upon the crystallines or metamorphics of the Piedmont Plateau. When on the latter, the clay contains a considerable admixture of quartz and other crystalline fragments. The same condition obtains at Halifax, N.C. as it does at any locality in the immediate vicinity of the crystallines. The beds rest upon Eocene at Ruffin's and Evergreen, Virginia, and, in the northern part of their range, upon some member of the Miocene series.

AREAL DISTRIBUTION AND FORMER CORRELATION

The areal distribution of the Murfreesboro stage is from about central Virginia to central North Carolina. Known exposures in Virginia are found along the York river, and on the Pamunkey river as near West Point. The whole series of blue clays found beneath the Yorktown stage on the James river belong to the Murfreesboro, as do the beds of similar lithology and stratigraphic position in northern and central North Carolina, as for examble at Halifax, Greenville, etc.

This stage has in general been misinterpreted, and different parts correlated with different portions of the Miocene series. The presence of beds of diatomaceous earth, seemingly in a continuous belt extending south from Maryland (as for example at Petersburg, Va.), and apparently closely associated with these beds, has led to their direct correlation with the similar deposits of the Calvert stage of Maryland. The evidence furnished by the more wide-spread and better known molluscan fauna is more trustworthy and should therefore be given more consideration than the presence of diatomaceous beds which might as well as not have been developed at different periods.

Heilprin* in 1884, although recognizing an intimate relation of the Virginian fossils to each other and therefore indicating a nearly uniform age, still held to his anomalous view, earlier expressed, of the continuation of his Marylandian or older Miocene south into Virginia and North Carolina, representing there the northern faunal horizon. He attributed this seeming difference in characteristics to ''imperfect observation or lack of observation.'' In 1904, Dall† compared the Maryland Miocene with other well-known localities. On the basis of the percentage of recent species, these localities were arranged in a series to show their relative ages. In this scheme, the Petersburg beds (included now in the Murfreesboro stage) were considered as being very old and beneath the Calvert or synchronous with it. For various reasons, final correlation by the percentage of the molluscan species which have survived to the present day cannot be relied upon for exact and detailed work. This principle is of use in pioneer work, but should be replaced by the more accurate evidence furnished by the identity or similarity of faunas. In 1912, Clark and Miller* referred the beds at Petersburg and those mentioned above on the Pamunkey river to the Calvert stage, and the remainder of the Murfreesboro stage as here defined to the St. Mary's. It should not be understood that no Calvert or St. Mary's is known in Virginia, as both are well represented in the northern or northeastern part of the state. In North Carolina, the stage includes all of the so-called St. Mary's of the same workers.†

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*Contributions to the Tertiary Geology and Paleontology of the Uuited States, pp. 15, 16.

†Maryland Geological Survey, Miocene volume, pp. cxlvii, cxlviii.

AGE DETERMINATION AND PALEONTOLOGY

Stratigraphically, the stage occupies a position immediately below the Yorktown, apparently conformable with it and thus in a manner its upper age limit is not sharply defined. For more precise age determination, the fossil evidence must be considered, and in itself is conclusive. An analysis of the Murfreesboro fauna corroborates the stratigraphic evidence and indicates a much closer relationship with the Yorktown than with the St. Mary's, or older beds. A considerably larger percentage of species are common to the Yorktown than to the Marylandian Miocene and the whole aspect of the fauna is of a more recent and advanced type. Several of the species of mollusks which have continued up from the lower and Middle Miocene show noticeable evolutionary changes, correlative with time, being either more perfect or having assumed senile characteristics. An example which might be cited is *Glycymeris subovatus*, a species commencing first in the upper Oligocene, where it is small, convex and rounded in outline. It is similar but rare in the lower and Maryland Miocene, becomes large and very abundant in the Murfreesboro, generally losing its convex form and becoming depressed with senility, indicated by an increase in thickness of the shell, variability of form and obsolescence of its sculpture.

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*Virginia Geological Survey, Bull. 4.

†North Carolina Geological and Economic Survey, vol. 3.

The best and most widely known of our Miocene fossils is the peculiar and interesting gasteropod *Ecphora quadricostata*. This species commences first in the Choptank, where it is represented by a widely umbilicated form, generally separated as the variety *umbilicata* of Wagner. In the St. Mary's beds the species becomes typical, continues up into the Murfreesboro and Yorktown stages, where it is large and often abundant. It is pre-eminently a cold water or Chesapeake species, and during Murfreesboro time, as will subsequently be shown, followed the Chesapeake fauna south into South Carolina and into Florida. During the milder portion of the Upper Miocene, the species persisted in the cooler portions of its range, that is, in the Yorktown basin north of the then already defined Hatteras axis. It is lacking from the more southern, warmer, but synchronous Duplin beds.

To the Murfreesboro stage belongs the distinction of having more species of Pectens than any other of our Miocene stages. Of the commoner Maryland species, all are represented except the Lower Miocene *Pecten humphreysii* and *marylandicus*. *Pecten jeffersonius* and *madisonius* have continued up from the Lower and Middle Miocene. Several species are peculiar. The Upper Miocene *Pecten eboreus*, makes its first appearance, becomes common and the dominant form in the Yorktown and the Duplin stages. Nearly confined as a fossil to the Murfreesboro and characteristic of it is *Pecten clintonius*, which in some localities is extremely abundant. The species is very rare in younger beds, but evidently persisted to the present day, the recent *P. magellanicus* , by many being considered identical. The species which are grouped around *P. virginianus* and *decemnarius* are nearly peculiar to the stage and are good index fossils.

Another group of the monomyarian pelcypods, abundant in the Murfreesboro stage, are the oysters, represented by about two species, namely *O. disparilis* and *sculpturata*. These two species are not known in Maryland, but are common and wide-spread in the Murfreesboro, Yorktown and Duplin stages.

The mactroid *Mulinia congesta* is an upper Miocene species not recorded from the St. Mary's or older beds. It is by far the commonest pelecypod of the Murfreesboro stage.

Amongst the gastropods, the Maryland Busycons such as *B. coronatum* and *fusiforme* are entirely lacking, their place being taken by the larger and more modern species as *B. maximum* and *incile.*

The Calliostomas, the smaller Nassas, Turritellas, all offer the same evidence. The whole fauna being distinctly of an upper Miocene type.

Since the Murfreesboro stage is older than the Yorktown, it is natural to expect that it should exhibit closer relation with the St. Mary's than is the case with the Yorktown.

Several species of Isocardias are abundant in the Maryland Miocene but are rare or entirely absent in the Yorktown and Duplin stages. They are well represented in the Murfreesboro and often extremely abundant in certain clay beds.

The geologic range of *Melina maxillata* is interesting, and the presence of this species associated with an upper Miocene fauna is the best criterion for the field identification of the Murfreesboro stage. This species is very abundant in our Lower Miocene, especially in the Choptank. It continues through the St. Mary's into the Murfreesboro and there sometimes equals, as far as number of specimens is concerned, its former importance in the Choptank. The species, so far as my knowledge goes, is entirely lacking from the Yorktown and Duplin stages.

THE MARYLAND MIOCENE

Since the Murfreesboro stage has frequently been correlated directly with the St. Mary's or older beds, a brief review of the more important paleontological characteristics of the Maryland Miocene may be of interest.

In many respects, the Miocene of Maryland is a unit, its different parts being more intimately related to each other than to outside Miocene. This relation is illustrated beautifully amongst the gastropods where the whole aspect of several families of shells is markedly different between the two states. For example in the family *Turritidæ* (*Pleurotomidæ*), the prevalent generic types in Maryland are *Turris* and *Surcula*, while that of the Drillia-like forms are much less in evidence. In the Murfreesboro and the Yorktown, not a single species of the genera *Turris* and *Surcula* are known, while *Drillia* is very abundant both in species and individuals. The smaller Nassas of the upper Miocene have a distinctly modern appearance, very different from the Lower and Middle Miocene species. Another example might be selected from the *Terebridæ*. In the Maryland Miocene this family is well represented by the genus *Hastula* and comparatively few true Terebras. The genus *Hastula* is entirely unknown in the Virginia and Carolinian Miocene. Its place is taken by a multitude of true Terebras, many of which are related to recent types. Further examples are unnecessary, but a number of others could be selected and would furnish much the same sort of evidence.

The highest stratigraphic stage of the Maryland Miocene is the St. Mary's and therefore approaches most nearly the age of Murfreesboro. Its fauna is peculiar, easily identified and of rather limited distribution. It is well developed at its type exposures along the St. Mary's river, at Cove Point, and Langley's Bluff, Md. In New Jersey, the stage has been recognized in several deep wells, as at Atlantic City, Wildwood, etc. In northern Virginia, beds of the same age occur along some of the northern rivers as on the Rapphannock.

In Maryland, where the St. Mary's stage is best known, it is characterized essentially by a gastropod fauna. At its type exposure, the following forms are very abundant: *Actæon ovoides*, *Hastula simplex*, *Turris communis*, *Raphitoma parva*, *Crassispira incilifera*, *Busycon coronatum*, *fusiforme*, *Buccinofusus parilis*, *Nassa peralta*, *Turritella plebeia*, *Calliostoma humile*. Amongst the pelecypods, the more conspicuous are *Spisula subponderosa* and

Arca idonea. Most of these species are peculiar to the St. Mary's, but a few have continued up from the Choptank and the Calvert, or are there represented by closely related forms. None of these species are known, except in a modified form in higher beds

GENERAL CORRELATION

In Virginia and North Carolina, the Murfreesboro stage is distinguished by having an Upper Miocene fauna associated with a small percentage of species which have continued up from the Lower Miocene, and a few which are peculiar, and therefore constitute index fossils. By means of these index fossils, and the general evidence furnished by the whole fauna, correlation with more distant Miocene deposits becomes possible.

For many years Tertiary beds have been known on Gay Head, Martha's Vineyard, Massachusetts, and a part of this group belongs to the Miocene series. Dall*, in 1894, visited the locality for the purpose of studying the fauna. He listed about thirty-three species of fossils of which twenty-two are mollusks. Significant species, and correlating with more southern Miocene, are *Cardium virginianum*, an index fossil of the Murfreesboro stage, and *Glycymeris reflexa* of the Murfreesboro and Yorktown. The beds therefore seem to be of Murfreesboro age, a conclusion which Dall himself practically reached. His statement is as follows: "As regards correlation with the divisions of the Southern Miocene it may be said 1: that the Gay Head Miocene is Chesapeake and not older; and 2, that it belongs in all probability to the upper part of the Chesapeake, certainly not lower than the St. Mary's fauna, and probably between that and the Yorktown beds."

In Florida, Miocene deposits are exposed in a narrow belt extending across the northern part of the state. During their deposition, a strait existed which connected the Atlantic with the Gulf and severed Florida from the mainland.

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*American Journal of Science, vol. 48, pp. 296-300.

At Alum Bluff, Miocene beds are exposed overlying uncomformably the Upper Oligocene. The contained fauna is strictly a southward extension of the Chesapeake and not of the nearer and warmer Duplin Miocene. Lithologically, the beds consist of blue or gray sands and are characterized by an abundant molluscan fauna of which the following species are noteworthy and of value for correlation.

Mulina congesta is the commonest fossil (range Murfreesboro-Pliocene), *Ostrea disparilis* (Murfreesboro-Yorktown and Duplin), *Cardium virginianum* (Murfreesboro), *Pecten eboreus* (Murfreesboro-Pliocene), *Ecphora quadricostata* (St. Mary's-Yorktown), *Busycon maximum* (Murfreesboro-Pliocene). These beds therefore correlate very well with the Murfreesboro of Virginia and North Carolina.

In South Carolina, Miocene is known to occur at several localities and available evidence indicates that two horizons or stages are represented. Since the appearance in 1857 of Tuomey and Holmes work on the Miocene and Pliocene faunas of that state, comparatively little has been done, so that the distribution of the Miocene faunas is known only in a general way. In an earlier paragraph the geological range and distribution of *Ecphora quadricostata* was considered and shown to be a cold water or Chesapeake species and lacking from the warmer Duplin beds. Its range is St. Mary's to the Yorktown. In South Carolina, *Ecphora quadricostata* is recorded by Tuomey and Holmes from the Miocene of the Pee Dee river. The age is therefore either St. Mary's or Murfreesboro, more probably the latter.